New Hampshire Volunteer Lake Assessment Program

2003 Interim Report for Great Pond Kingston

NHDES
Water Division
Watershed Management Bureau
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New Hampshire Department of Environmental Services

OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **GREAT POND, KINGSTON,** the program coordinators have made the following observations and recommendations:

Thank you for your continued hard work sampling the lake/pond this season! Your monitoring group sampled **three** times this season and has done so for many years! As you know, with multiple sampling events each season, we will be able to more accurately detect changes in water quality. Keep up the good work!

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake/pond has been monitored through the program.

  Chlorophyll-a, a pigment naturally found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity. **The mean (average) summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 7.02 mg/m^3.**

  NORTH STATION

  The current year data (the top graph) show that the chlorophyll-a concentration ***increased greatly*** from May to July, and then ***decreased greatly*** from July to August. The chlorophyll-a concentration in July was ***slightly greater than*** the state mean.

  The historical data (the bottom graph) show that the 2003 chlorophyll-a mean is ***less than*** the state mean.

Overall, visual inspection of the historical data trend line (the bottom graph) shows ***a relatively stable*** in-lake chlorophyll-a trend. Specifically, since monitoring began in 1995, the mean annual chlorophyll has ranged between approximately **3.5 and 5.0 mg/m³**. After 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historic data to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began.

SOUTH STATION

The current year data (the top graph) show that the chlorophyll-a concentration ***increased greatly*** from May to July, and then ***decreased greatly*** from July to August. The chlorophyll-a concentration in May and August was ***much less than*** the state mean, while the concentration in July was ***slightly less than*** the state mean.

The historical data (the bottom graph) show that the 2003 chlorophyll-a mean is ***less than*** the state mean.

Overall, visual inspection of the historical data trend line (the bottom graph) shows ***a slightly increasing (meaning slightly worsening)*** in-lake chlorophyll-a trend since monitoring began in 1991. In the 2004 annual report, we will conduct a statistical analysis of the historic data to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began.

While algae are naturally present in all lakes/ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes/ponds, phosphorus is the nutrient that algae depend upon for growth. Algal concentrations may increase with an increase in nonpoint sources of phosphorus loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). Therefore, it is extremely important for volunteer monitors to continually educate residents about how activities within the watershed can affect phosphorus loading and lake/pond quality.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for lake/pond transparency. Table 3 (Appendix B) lists the maximum, minimum and mean transparency data for each sampling season that the lake/pond has been monitored through the program.

Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. **The mean (average) summer transparency for New Hampshire's lakes and ponds is 3.7 meters.**

NORTH AND SOUTH STATIONS

The current year data (the top graph) show that the in-lake transparency ***remained relatively stable*** from May to July and from July to August. The transparency on each sampling event was ***less than*** the state mean.

Overall, visual inspection of the historical data trend line (the bottom graph) shows ***a relatively stable*** trend for in-lake transparency. Specifically, the mean annual transparency at each deep spot has ranged between approximately **2.5 to 4.0 meters** since monitoring began.

Typically, high intensity rainfall causes erosion of sediments into lakes/ponds and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake/pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake/pond. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from DES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amounts of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake/pond has joined the program.

  Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake/pond can lead to increases in plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 11 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

NORTH STATION

The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***increased slightly*** from May to July, and then ***decreased*** from July to August. The phosphorus concentration in May was ***approximately equal to*** the state median, in July was ***slightly greater than*** the state median, and in August was ***less than*** the state median.

The historical data show that the 2003 mean epilimnetic phosphorus concentration is ***approximately equal to*** the state median.

Overall, visual inspection of the historical data trend line for the epilimnion shows a ***relatively stable*** phosphorus trend since monitoring began in 1995.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***increased*** from May to July and then ***increased greatly*** from July to August (75 ug/L). The phosphorus concentration on each sampling event was ***greater than*** the state median.

It is important to point out that the turbidity of the hypolimnion (lower layer) sample was ***elevated*** on the **August** sampling event (5.02 NTUs). *This suggests that the lake/pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling. When the lake/pond bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting the hypolimnion sample, please check to make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.*

The historical data show that the 2003 mean hypolimnetic phosphorus concentration is ***much greater than*** the state median.

Overall, visual inspection of the historical data trend line for the hypolimnion shows an ***increasing (meaning worsening)*** phosphorus trend since monitoring began in 1995.

SOUTH STATION

The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***remained relatively stable*** from May to August. The phosphorus concentration on each sampling event was ***slightly less than*** the state median.

Overall, visual inspection of the historical data trend line for the epilimnion shows a ***relatively stable*** phosphorus trend since 1992. (Please note that the epilimnetic phosphorus concentration in 1991 was elevated.)

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***increased gradually*** from May to July and from July to August. The phosphorus concentration on each sampling event was ***greater than*** the state median.

The historical data show that the 2003 mean hypolimnetic phosphorus concentration is ***slightly greater than*** the state median.

Overall, visual inspection of the historical data trend line for the hypolimnion shows an ***increasing (meaning worsening)*** phosphorus trend since monitoring began in 1991.

It is also important to point out that the phosphorus concentration in the hypolimnion at the North and South deep spot has typically been ***greater than*** the phosphorus concentration in the epilimnion. This data indicates that ***internal phosphorus loading*** is occurring in the hypolimnion. (Please refer to the discussion of Table 9 and 10 for a detailed explanation of internal total phosphorus loading.)

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands.

TABLE INTERPRETATION

- **Table 2: Phytoplankton**

  Table 2 (Appendix B) lists the current and historic phytoplankton species observed in the lake/pond.

  North Station: The dominant phytoplankton species observed this year were ***Mallomonas* (a golden-brown algae), *Tabellaria* (a diatom), *and Anabaena* (a cyanobacteria).**

  South Station: The dominant phytoplankton species observed this year were ***Dinobryon* (a golden-brown algae), *Tabellaria* (a diatom), *and Mallomonas* (a golden-brown algae).**

Phytoplankton populations undergo a natural succession during the growing season (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession). Diatoms and golden-brown algae are typical in New Hampshire's less productive lakes and ponds.

An overabundance of cyanobacteria (previously referred to as blue-green algae), indicates that there may be an excessive total phosphorus concentration in the lake/pond, or that the ecology is out of balance. Some species of cyanobacteria, including ***Anabaena***, can be toxic to livestock, pets, wildlife, and humans.

Cyanobacteria can reach nuisance levels when excessive nutrients and favorable environmental conditions occur. During September of 2003, a few lakes and ponds in the southern portion of the state experienced cyanobacteria blooms. This was likely due to nutrient loading to these waterbodies. As mentioned previously, many weeks during the Spring and Summer of 2003 were rainy, which likely resulted in a large amount of nutrient loading to surface waters.

The presence of cyanobacteria serves as a reminder of the lake's/pond's delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading into the lake/pond by eliminating fertilizer use on lawns, keeping the lake/pond shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

In addition, residents should also observe the lake/pond in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria (blue-green algae) have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to "pile" cyanobacteria into scums that accumulate in one section of the lake/pond. If a fall bloom occurs, please contact the VLAP Coordinator.

- **Table 4: pH**

Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and reproduction of fish. A pH between 6.5 and 7.0 is ideal for fish. The mean pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.5**, which indicates that the surface waters in state are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean pH at the deep spots this season ranged from **6.15** in the hypolimnion to **6.79** in the epilimnion, which means that the water is ***slightly acidic.*** When organic matter near the lake bottom is decomposed, acidic by-products are produced, which explains the lower pH (higher acidity) in the hypolimnion.

Due to the presence of granite bedrock in the state and the deposition of acid rain, there is not much that can be done to effectively increase lake/pond pH.

- **Table 5: Acid Neutralizing Capacity**

  Table 5 (Appendix B) presents the current year and historic epilimnetic ANC for each year the lake/pond has been monitored through VLAP.

  Buffering capacity or ANC describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. The mean ANC value for New Hampshire's lakes and ponds is **6.7 mg/L**, which indicates that many lakes and ponds in the state are "highly sensitive" to acidic inputs. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

  The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) continues to remain ***slightly greater than*** the state mean. Specifically, the ANC at the **North Station** was **8.33 mg/L** and at the **South Station** was **8.67 mg/L**, which indicates that the lake/pond is ***highly sensitive*** to acidic inputs (such as acid precipitation).

- **Table 6: Conductivity**

  Table 6 (Appendix B) presents the current and historic conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current. The mean conductivity value for New Hampshire's lakes and ponds is **62.1 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

  The conductivity has ***decreased*** in the **Ball Road Inlet** since monitoring began. This ***decreasing*** trend in conductivity suggests the reduction of pollutants in the watershed. This reduction may be explained by decreased erosion in this area due to drainage improvements implemented through the Ball Road 319 Best Management Practices Grant. We hope that this trend continues!

The conductivity has ***increased*** at the North and South deep spots and in the **Great Pond Park Road Inlet, Kelley Brook Inlet, Thayer Road Inlet**, and the **Outlet** since monitoring began. In addition, the in-lake conductivity was at its ***highest*** since monitoring began. Typically, sources of increased conductivity are due to human activity. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the lake/pond), agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in bedrock, can influence conductivity.

It is possible that de-icing materials applied to nearby roadways during the winter months may be influencing the conductivity in the tributaries and in the lake. In New Hampshire, the most commonly used de-icing material is salt (sodium chloride). Therefore, we recommend that the inlets with elevated conductivity be sampled for chloride next season.

For a detailed explanation on how to conduct chloride sampling, please contact the VLAP Coordinator.

- **Table 8: Total Phosphorus**

Table 8 (Appendix B) presents the current year and historic total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The total phosphorus concentration was ***elevated*** in the **Ball Road Inlet** (79 ug/L), the **Thayer Road Inlet** (95 ug/L), and the **Outlet** (169 ug/L) on the **August** sampling event this season. The turbidity of these samples was also ***slightly elevated*** (2.76, 4.59, and 4.81 NTUs, respectively), which suggests that the stream bottom was disturbed while sampling or that erosion is occurring in these areas.

These inlet stations have had a history of ***fluctuating*** total phosphorus concentrations. We recommend that your monitoring group conduct stream surveys and storm event sampling along these inlets so that we can determine what may be causing the increases.

For a detailed explanation on how to conduct rain event and stream surveys, please refer to the 2002 VLAP Annual Report "Special Topic Article", or contact the VLAP Coordinator.

- **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**
  Table 9 (Appendix B) shows the dissolved oxygen/temperature profile(s) for the 2003 sampling season. Table 10 (Appendix B) shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The dissolved oxygen concentration was ***low in the hypolimnion*** at both deep spots of the lake/pond. As stratified lakes/ponds age, and as the summer progresses, oxygen becomes ***depleted*** in the hypolimnion (the lower layer) by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment.

  During this season, and many past sampling seasons the lake/pond has had a lower dissolved oxygen concentration and a higher total phosphorus concentration in the hypolimnion (the lower layer) than in the epilimnion (the upper layer). These data suggest that the process of ***internal total phosphorus loading*** (commonly referred to as ***internal loading***) is occurring in the lake/pond. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion **(as it was this season at the North Station and in many past seasons at both deep spots)**, the phosphorus that is normally bound up with metals in the sediment may be re-released into the water column.

  Again, this may explain why the phosphorus concentration in the hypolimnion is ***greater*** than the phosphorus concentration in epilimnion. Since an internal source of phosphorus in the lake/pond may be present, it is even more important that watershed residents act proactively to minimize external phosphorus loading from the watershed.

- **Table 11: Turbidity**
  Table 11 (Appendix B) lists the current year and historic data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is

strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

As discussed previously, the turbidity of the hypolimnion (lower layer) sample was elevated on the **August** sampling event. This suggests that the lake/pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling.

In addition, the turbidity in a few of the inlet samples was also elevated on the August sampling event, which suggests that the stream bottom may have been disturbed while sampling or that erosion is occurring.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:

During the annual visit to your lake/pond, the biologist conducted a "Sampling Procedures Assessment Audit" for your monitoring group. Specifically, the biologist observed the performance of your monitoring group while sampling and filled out an assessment audit sheet to document the ability of the volunteer monitors to follow the proper field sampling procedures (as outlined in the VLAP Monitor's Field Manual). This assessment is used to identify any aspects of sample collection in which volunteer monitors are not following the proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples that the volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group did an ***excellent*** job collecting samples on the annual biologist visit this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Keep up the good work!

Sample Receipt Checklist:

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did an ***excellent*** job when collecting samples and submitting them to the laboratory this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the laboratory staff to contact your group with questions, and no samples were rejected for analysis.

NOTES

NORTH STATION

- **Biologist's Note (7/1/03):** The total phosphorous concentration In the hypolimnion was elevated as was the turbidity. This suggests that the lake bottom was disturbed while sampling.
  (8/1/03): The total phosphorous level at the hypolimnion was found to be high.

SOUTH STATION

- **Biologist's Note (7/1/03):** The total phosphorous concentration was elevated at Ball Rd. Inlet and Thayer Rd. Inlet.
  (8/1/03): The total phosphorous levels at Ball Rd. Inlet, Outlet, and Thayer Rd. Inlet were Found to be high.

USEFUL RESOURCES

Acid Deposition Impacting New Hampshire's Ecosystems, ARD-32, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/ard/ard-32.htm.

Aquarium Plants and Animals: Don't leave them stranded. Informational pamphlet sponsored by NH Fish and Game, Aquaculture Education and Research Center, and NHDES (603) 271-3505.

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, *NHDES-WD 97-8*, NHDES Booklet, (603) 271-3503.

A Boater's Guide to Cleaner Water, NHDES pamphlet, (603) 271-3503.

Camp Road Maintenance Manual: A Guide for Landowners. KennebecSoil and Water Conservation District, 1992, (207) 287-3901.

Comprehensive Shoreland Protection Act, RSA 483-B, WD-SP-5, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-5.htm.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, WD-SP-1, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-1.htm

Impacts of Development Upon Stormwater Runoff, WD-WQE-7, NHDES Fact Sheet, (603) 271-3503, or www.des.state.nh.us/factsheets/wqe/wqe-7.htm

Iron Bacteria in Surface Water, *WD-BB-18*, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-18.htm

Is it Safe to Eat the Fish We Catch? Mercury and Other Pollutants in Fish, NH Department of Health and Human Services pamphlet, 1-800-852-3345, ext. 4664.

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, *WD-BB-9*, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-9.htm.

Management of Canada Geese in Suburban Areas: A Guide to the Basics, Draft Report, NJ Department of Environmental Protection Division of Watershed Management, March 2001, www.state.nj.us/dep/watershedmgt/DOCS/BMP_DOCS/Goosedraft.pdf.

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, WD-SP-2, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-2.htm.

Road Salt and Water Quality, WD-WMB-4, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/wmb/wmb-4.htm.

Sand Dumping - Beach Construction, *WD-BB-15*, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-15.htm.

Swimmers Itch, *WD-BB-2*, NHDES Fact Sheet, (603) 271-3503 or *www.des.state.nh.us/factsheets/bb/bb-2.htm.*

Through the Looking Glass: A Field Guide to Aquatic Plants. North American Lake Management Society, 1988, (608) 233-2836 or www.nalms.org.

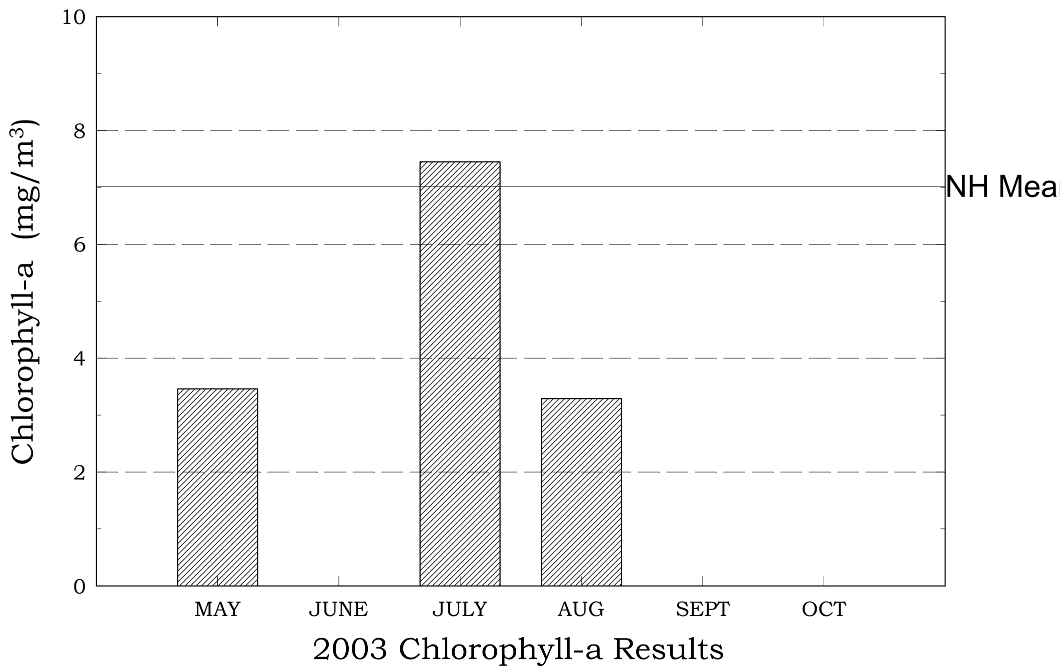
Weed Watchers: An Association to Halt the Spread of Exotic Aquatic Plants, WD-BB-4, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-4.htm.

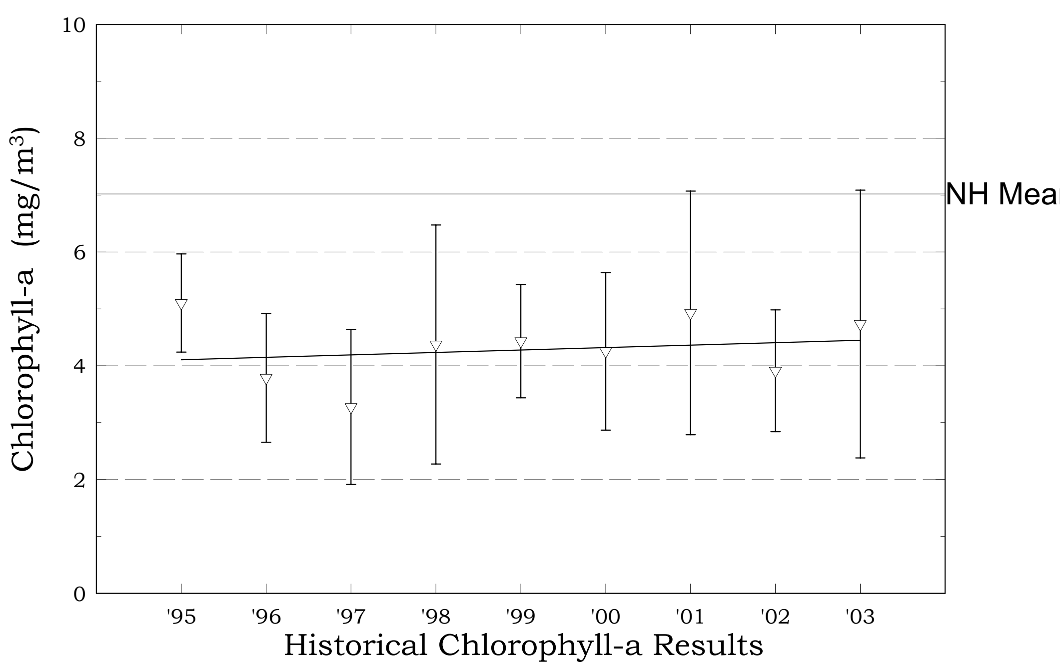
APPENDIX A

GRAPHS

Great Pond, North, Kingston

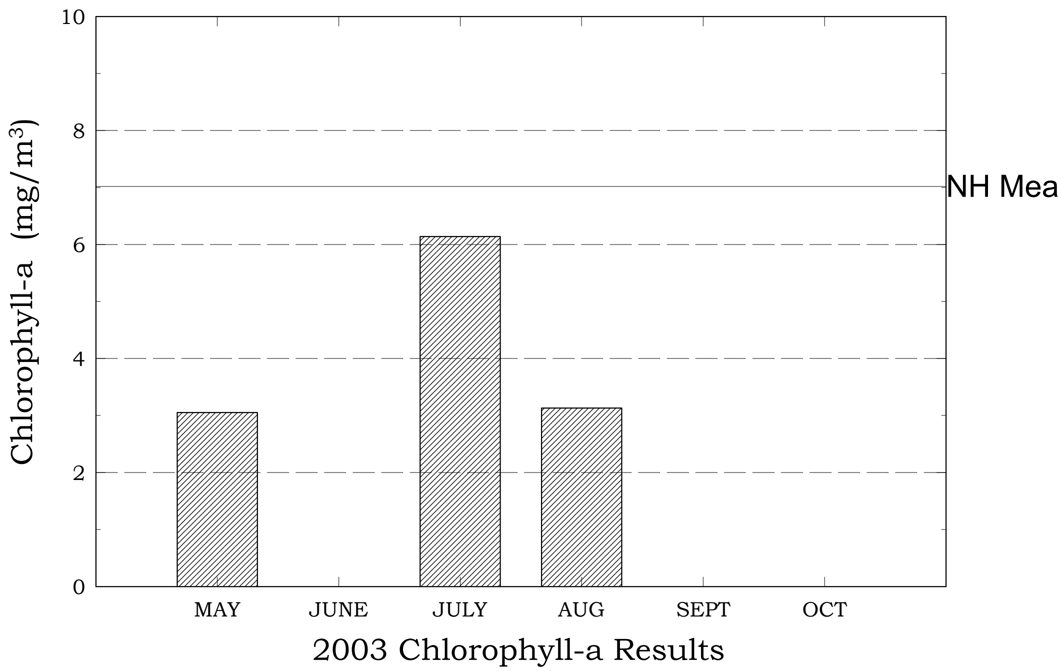
Figure 1. Monthly and Historical Chlorophyll-a Results

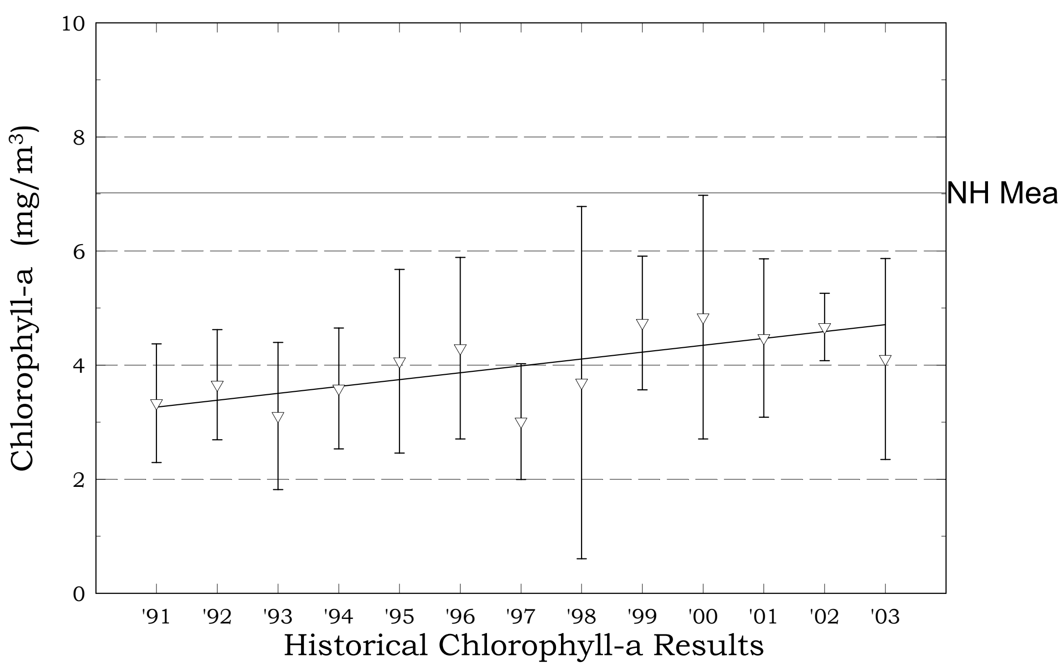




Great Pond, South, Kingston

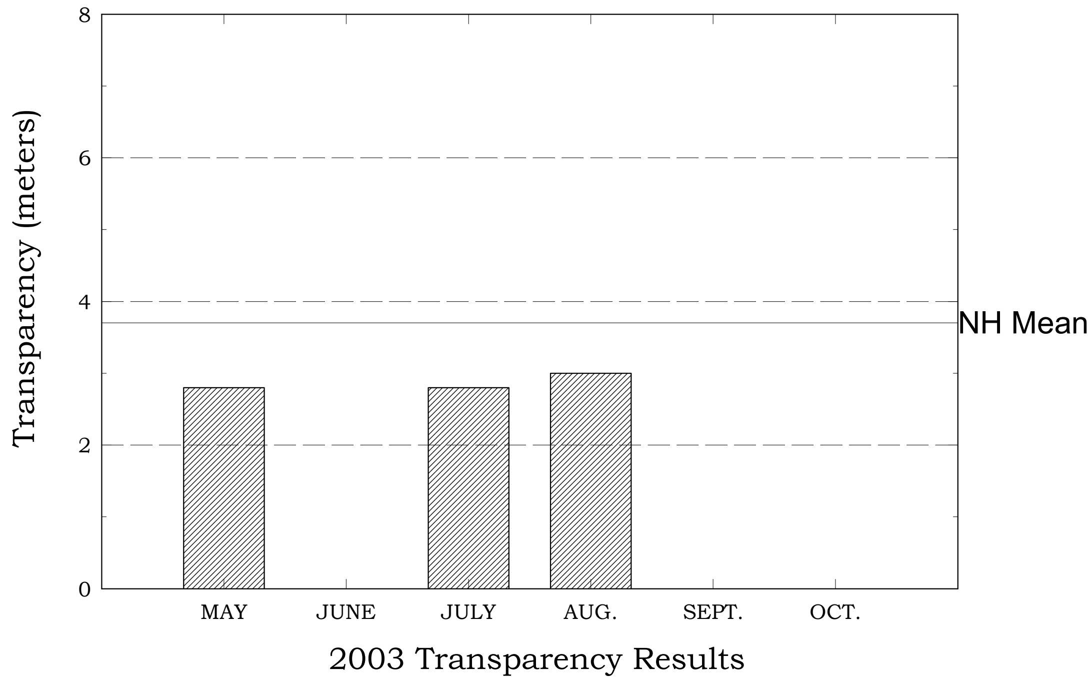
Figure 1. Monthly and Historical Chlorophyll-a Results

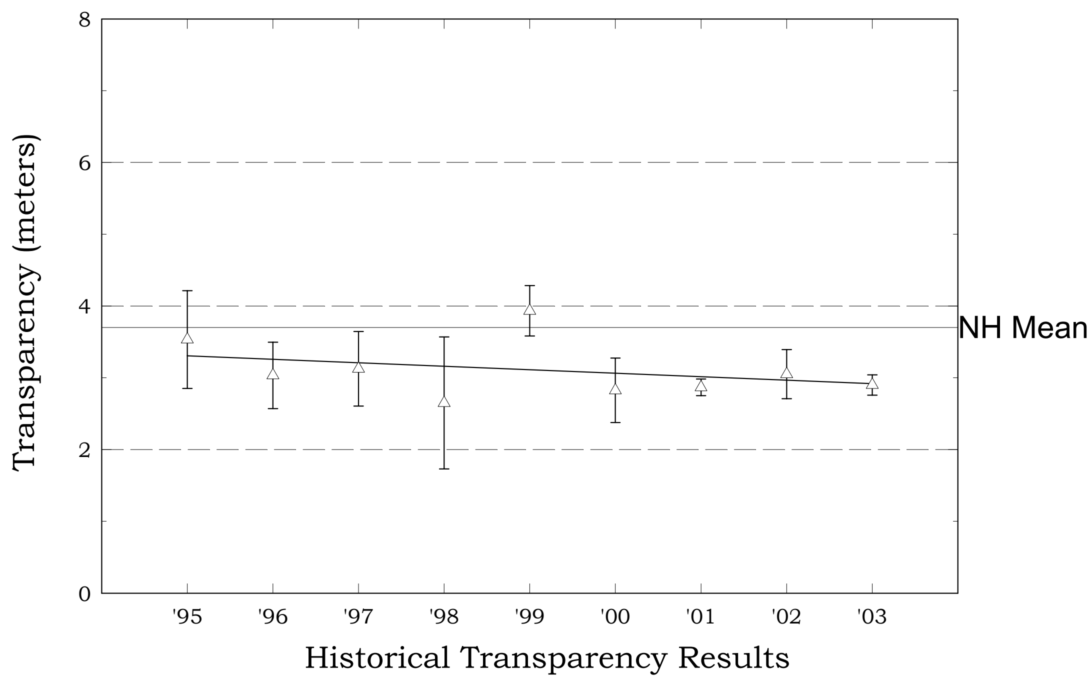




Great Pond, North, Kingston

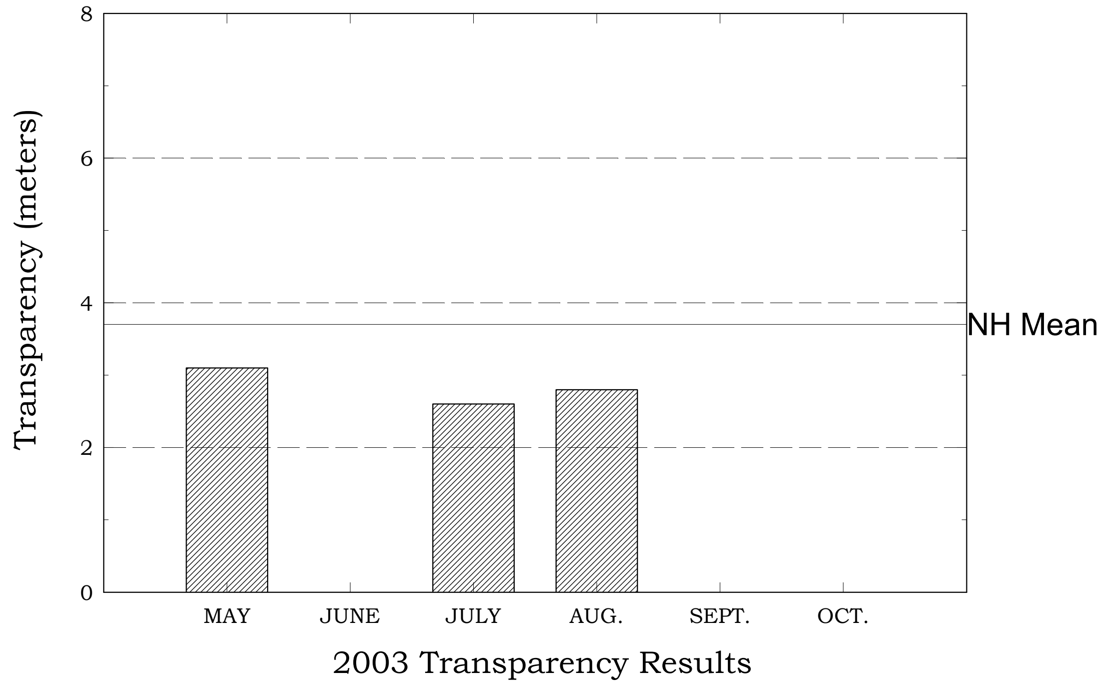
Figure 2. Monthly and Historical Transparency Results

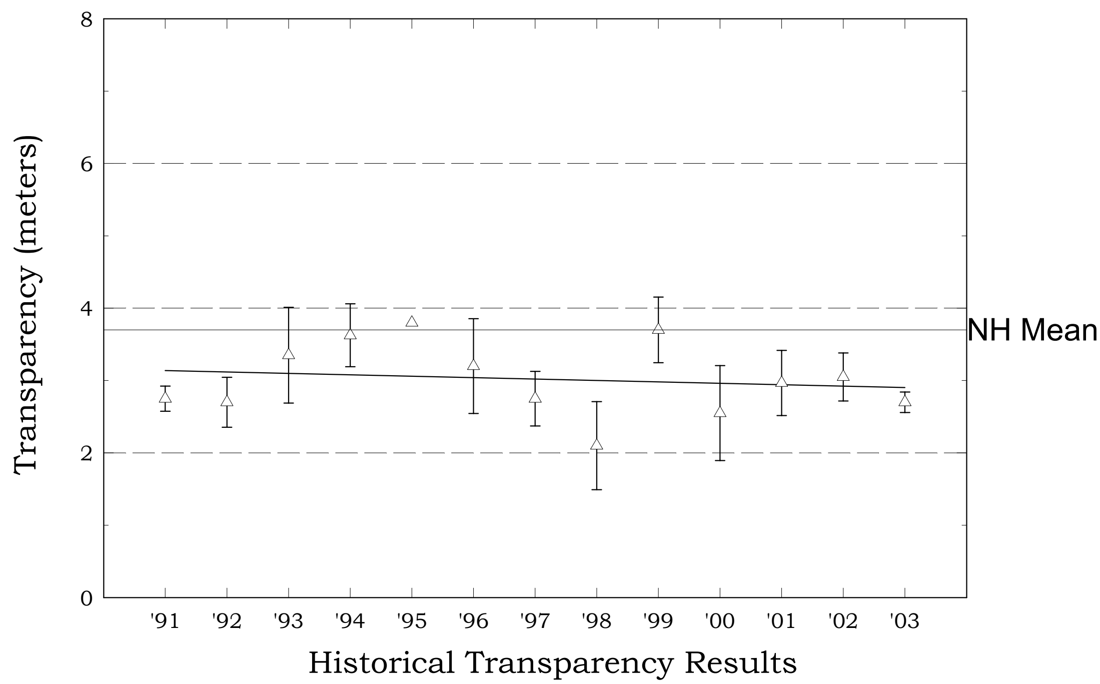




Great Pond, South, Kingston

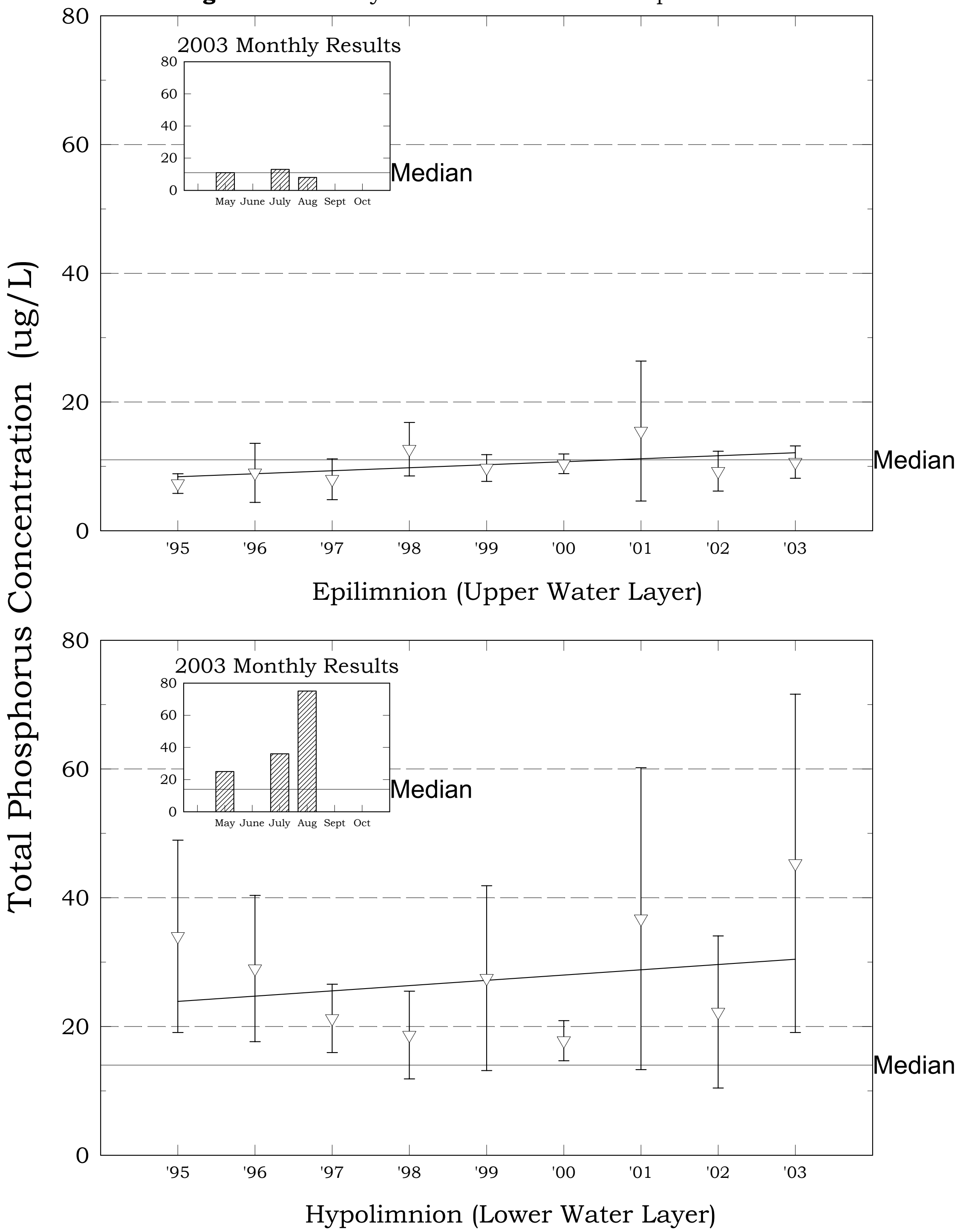
Figure 2. Monthly and Historical Transparency Results





Great Pond, North, Kingston

Figure 3. Monthly and Historical Total Phosphorus Data.



Great Pond, South, Kingston

Figure 3. Monthly and Historical Total Phosphorus Data.